Strategies for adapting to water stress in the arid and semi-arid regions of Africa

People living in Africa's arid and semi-arid lands face huge climate-related challenges, including less predictable rainfall, more frequent extreme weather events and increasing temperatures. In response, IDRC is working with urban and rural communities to identify practical and affordable solutions to protect lives and strengthen livelihoods.

B. NDUMA

A research project in Kenya identified suitable, drought-resistant crops and investigated water-efficient farming systems for local farmers to address climate change-related challenges.

Summary

In the arid and semi-arid lands (ASALs) of the Sahel and East Africa, rising temperatures and growing water stress are putting farming systems under extreme pressure, raising fears about the future for traditional rural livelihoods. Meanwhile, in poorer urban neighbourhoods, water supply systems are struggling to cope with ever-increasing demand and scarcity, a situation that will only get worse with projected future climate variability and change. Addressing such challenges demands a wide range of actions at national, local and community levels, including: training and support for climate-resilient crop and livestock production systems; new initiatives such as feed and water storage; provision of credit to fund smallholders' adaptation strategies; and education and advocacy for behavioral change and conflict resolution.

IDRC's Climate Change and Water program has supported research in the ASALs of Benin, Burkina Faso and Kenya, generating data and knowledge that can inform adaptation strategies throughout Africa's dry land regions. This brief synthesizes the lessons from the above research on a number of key themes common to all three countries.

The problem

Lives and livelihoods in the ASALs of Africa are under increasing pressure from changing weather patterns, including reduced, less predictable and less evenly distributed rainfall, more frequent extreme weather events such as droughts, floods and storms, and rising temperatures. For farming households in northern Burkina Faso, for example, more frequent and longer dry spells during the growing season are having a significant impact on crop development and yields. Annual grain harvests have fluctuated by an average of 20% in northern Burkina Faso since the 1980s and even when rainfall totals stay constant, the increasing tendency for rain to be concentrated in a few heavy downpours is difficult for farmers to cope with. Frequently, flooding and strong winds compound the damage already inflicted by drought. In parts of Benin, maize yields are predicted to fall by 6% by 2025. Historic planting dates and traditional agricultural practices are becoming obsolete due to shifting seasons, and the country is increasingly vulnerable to climate risks such as droughts, rainfall variability, floods and high winds. To the east, in Kenya's ASALs, mean temperatures are predicted to rise by 3-4°C by 2100, leading to increased water scarcity and reduced productivity in maize, sorghum and other staple crops such as beans and pigeonpea. Maize production in particular, the main staple food crop in the region, is predicted to fall 50% by 2030 posing serious food insecurity. Declining groundwater levels are causing salt-water intrusion into crop fields, which further impacts on crop yields and land productivity. With rainfall patterns increasingly unpredictable, farmers are left unsure of when to plant their crops and how long the growing season will last, thereby reducing the incentive to invest in farming inputs such as improved seed or fertilizer. Livestock farmers are also facing serious challenges. In recent years, Kenya's livestock sector has been repeatedly devastated by prolonged drought and rising temperatures, with rain-fed pastures unable to support the large numbers of relatively unproductive animals kept by pastoralists.

During extreme weather events, such as prolonged drought, traditional coping strategies have failed. Research in Burkina Faso has revealed that soil moisture conservation techniques, such as the use of *zai* planting pits and half-moon runoff catchers, are unable to save crops from long dry spells in a growing season, even though such methods continue to prove their worth under less extreme conditions. While supplementary irrigation has the potential to protect crops against such dry spells, in Burkina Faso and other parts of the Sahel it has been a forbidden taboo, on the grounds that only God can send rain.

Limited access to water resources in the ASALs is putting increasing pressure on people's daily lives, triggering serious resource conflicts. In the urban centres such as Burkina Faso's capital, Ouagadougou, long queues at community water taps and standpipes are evident. Scarcity of water has also led to people drinking from polluted sources, increasing rates of water-borne disease such as cholera. In the ASALs of Kenya, serious conflicts in relation to scarce water resources have been witnessed between and among pastoralists, agro-pastoralists (who grow crops as well as keep livestock) and wildlife. For instance, farmers frequently plant their crops along river banks and use river water for irrigation, reducing the amount of water available to livestock. Border areas of Kenya, Ethiopia and South Sudan have also seen conflicts between livestock herding groups, who compete for the scarce water and greener grazing fields.

Research focus

Through the Climate Change and Water program, IDRC has supported research focused on identifying practical and affordable solutions to climate change related challenges in the ASALs of the Sahel and East Africa. These solutions include developing and testing new crop varieties, use of water-efficient farming practices, introducing new technologies for water conservation and storage, and enhancing access to climate information to support planning and decision-making processes. Research initiatives include:

Benin

Introducing new agricultural practices, such as combination of maize, leguminous green manure crops and improved planting pits, and evaluating their resilience and productivity to changing climate patterns. The project also collaborated with local communities to test the effectiveness of planting at different times, and strengthened the capacity of farmers and extension staff to adopt and spread new technologies.

Burkina Faso

Assessing water quality for domestic use in informal settlements of Ouagadougou, and evaluating the effectiveness of different practices for household water collection and storage. The project also analyzed rates of disease incidence, particularly for diseases connected to poor water supply and sanitation (e.g. malaria, cholera, and diarrhea).

Introducing and evaluating the use of rainwater storage basins to provide supplemental irrigation during dry spells, and testing how supply of information on the timing of the rainy season impacted crop yields. This work was conducted in Bam and Yatenga provinces in the north of the country.

Kenya

Identifying suitable, drought-resistant crops acceptable to local farmers and investigating water-efficient farming systems. The project supported pastoralists to shift towards more productive, climate-resilient livestock breeds and adopting fodder production and storage for use in times of feed shortage. Furthermore, the project trained farmers on improved pasture production and informed county livestock development policies.

2iE

In Burkina Faso, rainwater storage basins provided supplemental irrigation during dry spells for better crop yields.

Adaptation solutions

Shifting to new crop types/varieties and livestock breeds

The research has highlighted a number of promising strategies for coping with drought. In some areas, farmers may need to actually change the crops they are growing, or the types of livestock they are keeping, in order to survive. In Kenya, for instance, short-season and drought-tolerant crops such as pigeonpeas and cowpeas were found to cope better with unreliable rainfall patterns than conventional crops. Some alternative crops, such as improved sweet potato and cassava, were found to actually adapt more and yield better under the predicted changes in temperature and rainfall, yielding up to 40% more compared with other conventional crops grown in the same season. For livestock farmers, the adoption of more productive, climate-tolerant livestock breeds may be a key strategy. Sahiwal and improved Boran cattle, and Dorper and Red Masaai sheep are breeds that cope relatively well under harsh climatic conditions. Farmers in semi-arid Kenya were also encouraged to rear camels, which are highly resilient.

Embracing climate-resilient farming practices

Farming practices can also be adapted to make them more climate-resilient. In Benin, the project found that intercropping maize with mucuña (*Mucuna pruriens*) led to a significant increase in maize yields. The mucuña, known as a 'green manure' crop for its ability to boost soil fertility, also acts to reduce the evaporation of soil moisture, thereby helping the maize to withstand dry spells. In a farmer field school, farmers were able to achieve maize yields of 1.7 tons/ha growing maize with mucuña, compared to 0.8 tons/ha for maize grown alone. In Kenya, farmers used *zai* planting pits to grow maize, beans,

sorghum and sweet potatoes, and increased the depths of the pits to prolong the period before crops withered during extreme dry spells. The *zai* planting pits were combined with the use of water-holding materials, such as plant residues and organic manures, which boost plant growth and minimise water losses. Combining the use of planting pits with organic fertilizer increased maize yields by 50% in a normal season and reduced losses by up to 30% during drought. By cultivating crops in former livestock pens, farmers were consistently able to produce up to three times more yields than attained in unfertilized fields.

Crop diversification

Crop diversification helps to maintain community livelihoods, food security and nutrition. Research in Kenya found that crop diversification in ASALs, according to cost-benefit projections, would yield over 40 times the investment cost within the first 10 years, with potential for benefits to increase further through widespread adoption. Despite these strong benefits, however, introducing such strategies depends on public support for research, farmer training, technology adaptation and supply of fertilizers and seed.

In Benin, the project investigated how combining the cultivation of different crops within a field would impact on crop productivity. In addition to the success with maize and mucuña, as described above, farmers also experimented with co-planting of maize and pigeonpea. This work revealed that maize yields increased to 1.2 tons/ha when co-planted with pigeonpea compared to 0.8 tons/ha for maize grown alone (50% increase). In Burkina Faso, access to stored rainwater in storm-water collection basins enabled women farmers to increase their production of watermelons, tobacco and vegetable crops. As a result, the women's income increased substantially, with average earnings of US$120 from sales of vegetables; household nutrition also improved through greater dietary diversity.

Improving pastures

Improving pastures through the planting of climate-resilient varieties of pasture grass, such as Sudan grass (*Sorghum sudanense*) or African foxtail grass (*Cenchrus ciliaris*), is another valuable strategy. Research in Kenya found that one acre of Sudan grass grown under improved pasture production yielded up to 3.6 tons of feed annually, enough to sustain milk production for up to four cows throughout the year.

Establishing feed and water reserves

Planning to cope with drought is key to farming survival in the ASALs. Through the IDRC projects, farmers experimented with strategies to store available water resources for times of need. In Kenya, the project recommended the establishment of county feed reserves, which can buy fodder from farmers during times of excess production for redistribution during times of drought. In northern Burkina Faso, the project introduced the use of large basins or ponds for storing rainfall runoff. The stored water is used to provide supplemental irrigation, keeping crops alive when dry spells interrupt the growing season. Prior to the project, there was no supplemental irrigation in the area due to cultural reasons explained earlier. After the project, 75% of farmers adopted the technology and 60% were ready to contribute financially to constructing the basins in future. In Bam province, supplemental irrigation increased maize yields from 2 to 3 tons/ha (50% increase); the impact was even more marked in Yatenga province, with an increase from 1 to 2.2 tons/ha (120% increase).

Improving water management

Improving water management is critical for adapting to climate change. For crop farmers, flooding can be just as devastating as drought. In Benin, farmers installed stone bunds and trenches within their fields to limit the extent of flooding and remove floodwater. This shortened the amount of time that crops stood in floodwater and reduced losses by at least 65% during floods experienced in 2012 and 2013, compared to 2010. In the unplanned settlements of

IDID-ONG

Agricultural practices, such as intercropping and using improved planting pits, strengthened the capacity of local farmers in Benin.

Ouagadougou, water management strategies took a different form. Here, to address the problem of high microbial contamination in domestic water supplies (4-8 in every 10 households were found to be drinking water contaminated by coliform bacteria), the project promoted the adoption of improved hygiene practices at public water points, as well as installation of proper drainage and sanitation facilities. Households were introduced to hygienic practices during collection, transportation, storage and use of water to avoid diarrhea and other water-borne diseases.

Improving access to information

Provision of information is crucial if households are to cope with challenges posed by changing climate, including extreme weather. In Benin, the project worked with communities to develop new planting dates for the north, centre and south of the country. These replaced planting dates determined in the 1970s, which had long been obsolete owing to changes in annual rainfall patterns. In Burkina Faso, providing information on the start of the growing season allowed 90% of farmers involved with the project to plant at the right time and avoid the need for reseeding. This not only saves costs, but also saves labor, allowing much more efficient use of human resources. In Kenya, farmers receive seasonal forecasts and agro-advisories based on downscaled

S. ROUAMBA

Assessing water quality in Ouagadougou, Burkino Faso alongside more hygienic practices during collection, transportation, storage and use of water helped to reduce microbial contanimation.

climate information before the onset of the season to improve many farming decisions, such as choice of crop, seed variety and other strategies to mitigate the adverse effects as projected in the forecasts. Many farmers now seek meteorological data and appropriate seeds from government offices before the start of every farming season.

Future investments and research priorities

Local and national governments, specifically agricultural authorities, should support and promote a wide range of strategies to enhance community resilience to the impacts of climate change and variability. Investment in extension services and technical staff will be necessary, including use of farmer field schools and demonstration centres, to ensure that households can embrace new, climate-smart systems of crop and livestock production and soil and water conservation. These adaptation strategies may include construction of run-off collection basins, use of water efficient irrigation techniques such as drip irrigation, livestock breeding management, on farm flood defences and improved water-conserving systems of crop production. Providing credit to farmers to fund adaptation strategies will also be key, and is likely to require a coordinated approach by government, farmers' organizations and microfinance institutions, in order to establish guaranteed funds as backing for farmer loans.

Local governments or authorities should consider establishing new, tailor-made services and initiatives to address climate challenges. In the pastoral areas, local governments should establish strategic feed reserves to save livestock from starvation during times of extended drought. Grazing management should also be reorganized and managed to preserve pasture for times of extreme shortage, and breeding systems should be set up to ensure the availability of high quality bulls, bucks and rams of productive, resilient breeds. In crop farming areas, local authorities should support establishment and management of seed multiplication centres of improved, drought-tolerant varieties. Local development plans should prioritize and mainstream climate adaptation strategies in all their projects. In the informal urban settlements, climate change adaptation plans may also require stronger enforcement of water supply hygiene rules.

Community associations, opinion leaders and NGOs should invest in advocacy and education around climate and adaptation issues. In urban areas, women in particular should receive training in hygienic water collection, transport, storage and use, in order to bring about behavior change. In pastoral areas, advocacy and training on grazing and water resource management is needed to reduce conflicts over water and grazing points, including the need to set aside certain pastures and fields for times of emergency. Facilitation of discussions between upstream and downstream river basin communities can achieve more equitable water-use agreements.

Understanding the comparative benefits of individual versus community land ownership, in terms of livestock and pasture management, needs further investigation by researchers. This can help to inform local and national governments in responding to the demand by some farmers for individual ownership. Researchers have also realised the need to develop an integrated model that combines climatic and non-climatic factors that currently guide farmers' decision-making around crop and livestock production. Understanding the complexity of factors involved will ensure that development efforts can be better targeted. In urban areas, particularly informal settlements, research is needed to study the impact of water quality on morbidity, and to evaluate the economic impact of water-related morbidity. This work will strengthen the case for action to improve safe water provision.

Contributing authors:

Patrick Ketiem, Abdoulaye Diarra, Abdramane Soura and Roger Konou.

More information

To learn more about climate change research funded through IDRC, please visit: www.idrc.ca/ccw

Edith Ofwona: eadera@idrc.ca

@IDRC_CRDI

/IDRC.CRDI

/IDRCCRDI

International Development Research Centre
Phone: +1 613 236 6163
Fax: +1 613 238 7230
info@idrc.ca
www.idrc.ca

Produced by **WRENmedia** in May 2015